REMARKS

The Applicants thank the Examiner for the thorough consideration given the present application. Claims 5-11, 15, 18, 20, 23, and 35-38 were previously cancelled. Claims 1-4, 12-14, 16, 17, 19, 21, 22, 24-34 and 39 are pending, of which claim 39 is added. Claim 1 is independent.

The Examiner is respectfully requested to reconsider the rejections in view of the amendments and remarks set forth herein.

Examiner Interview

If, during further examination of the present application, a discussion with the Applicants' Representative would advance the prosecution of the present application, the Examiner is encouraged to contact Carl T. Thomsen, Registration No. 50,786, at 1-703-208-4030 (direct line) at his convenience.

Rejections Under 35 U.S.C. §103(a)

Claims 1-4, 12-14, 16, 17, 19, 21, 24-26, 28-31, 33, and 34 stand rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al. (U.S. 4,283,228) and further in view of Fernandez et al. and Srivastava et al. (U.S. 5,433,917);

claim 22 stands rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al., and further in view of Fernandez et al., Srivastava et al., and Maas et al;

claim 27 stands rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al., and further in view of Fernandez et al., Srivastava et al., and Yao et al.; and

claim 32 stands rejected under 35 U.S.C. §103(a) as being unpatentable over GB 2161647 in view of Buchanan et al., and further in view of Fernandez et al., Srivastava et al., and Chen et al.

These rejections are respectfully traversed.

Arguments Regarding Independent Claim 1 as Previously Presented

Independent claim 1 as previously presented recites a combination of steps directed to a method of producing a piezoelectric ceramic thick film on a substrate, said method comprising:

- mixing liquid phase precursors of Li_2O and Bi_2O_3 metal oxides to form a Li-Bi solution;
- forming a suspension of a piezoelectric ceramic material in powder form and a fluid medium by ultrasonic vibration;
- forming a liquid mixture by mixing the suspension of powdered material with the Li-Bi solution, the Li_2O and Bi_2O_3 having melting points lower than a temperature required for densifying the piezoelectric ceramic thick film by sintering, said liquid mixture obtained by mixing the suspension of powdered material and the Li-Bi solution having a greater degree of homogeneity than that of a mixture obtained by mechanically mixing the powdered material.

Regarding GB 2161647

The Examiner concedes that GB 2161647 does not teach the liquid phase precursor of metal oxide for the binding agent.

Regarding Buchanan et al.

The Examiner cites U.S. 4,283,228 by Buchanan et al. as the prior-art to arrive at the conclusion that the metal oxide sintering aids have been introduced from liquid phase precursor. Abstract, col. 2, line 5-15, and col. 4, lines 25-25, U.S. 4,283,228 have been cited to support the Examiner's view.

However, the cited contents do not support the conclusion of the Examiner. When V2O5 is used as a sintering aid for the PZT powder by Buchanan et al., the PZT "was milled and blended with" V2O5 as dispersed in isopropyl alcohol (note V2O5 is dispersed, but not dissolved as in a real liquid phase). (Column 3, Lines 25-30.) This is merely dispersed solid particles, which is different from the real liquid phase precursor as set forth in independent claim 1 (Li-Bi solution). In other words, the Buchanan et al. document teaches away from the present invention. Although Buchanan et al. (U.S. 4,283, 228) mentions ammonium vanadate, vanadyl salts, or V2O5-affording promoter generally (Lines 5-15 in Column 2, Line 25-35 in Column 4), these chemicals are simply intended to use as a source of V2O5 to react with PZT. Therefore, Buchanan et al. fail to disclose any process about how to take use of their liquid phase solution to realize a uniform mixing with PZT powder when the V2O5 is used as a sintering aid.

Independent claim 1 of the present application sets forth specified Bi and Li compositions as the sintering aids. The complex oxides have dramatically different specific gravities with each other, and V2O5 is just a simple oxide. Different compositions must be prepared using different chemicals to obtain stable solution or suspension system for realizing homogeneous mixing with the piezoelectric powder. For a person having ordinary skill in the art, it is clear that a homogeneous distribution of the sintering aids in the thick films is important. What critical is how they can be introduced with great homogeneity effectively. There is no prior art teaching the method about how to introduce Li2O and Bi2O3 through a proper liquid phase precursors. In the present invention, Li ethoxide in ethanol and Bi nitrate in acetic acid (Claims 7-8) are used as precursors and they are mixed and reacted to form a transparent and stabilized Li-Bi solution before mixing with the piezoelectric powder. The Bi-Li solution of the present application is actually a colloid-like solution with certain viscosity and expected to be coated on the surface of the ceramic powder to realize the homogeneous mixing between the Bi-Li precursor chemicals and ceramic powder (technical principles and details refer to our publication: *Sensors & Actuators A*, Vol 118/2, pp 342-348, Feb 2005). All the cited prior arts fail to teach any Bi-Li solutions with the desired viscosity and substantial coating effect, and in such situation, the ceramic power just quickly precipitates from the solution without a homogeneous mixing or desired coating effect.

The characteristics of Bi-Li solution precursors are also dramatically different from any solid precursors including solid glass particles or any solid precursor particles suspended

in another liquid (suspension is not a real liquid). The thick film preparations as in cited just demonstrate that the process is successful for paste from conventional piezoelectric powder and glass powder as the sintering aids. Without the experimental efforts of the present inventors, it is impossible to know whether the homogeneity realized through the liquid phase doping approach will be destroyed or not.

Thick film pastes contain a large amount of organic solvent, and the conclusions in bulk ceramic can not be simply applied to thick films.

Even if homogeneity has not been achieved actually, piezoelectric properties could still be demonstrated as claimed in the prior art cited by the Examiner. However, the enhanced homogeneity can improve the reliability and stability. It should be noted that the present inventors have obtained piezoelectric ceramic thick films using the claimed preparation method with stable piezoelectric vibration module of the thick film observed for the 1st time for the ceramic thick films by screen printing (in our publication: *Sensors & Actuators A*, Vol 118/2, pp 342-348, Feb 2005.). No report of similar vibration model has been found in the literature for the screen-printed piezoelectric ceramic thick films sintered at similar low temperature.

Regarding Fernandez et al.

The Examiner concedes that the combination of GB 2161647 and Buchanan et al. fails to teach milling the PZT powder and carrier to form a paste.

Fernandez et al. was cited merely to disclose milling to form a paste

Regarding Srivastava et al.

The Applicants believe that the Srivastava et al. (U.S. 5,433,917) document does not disclose anything regarding independent claim 1 as previously presented.

Summary

The Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness.

Section 2143 of the M.P.E.P. sets forth various examples of basic requirements of a *prima facie* case of obviousness:

> The Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1395-97 (2007) identified a number of rationales to support a conclusion of obviousness which are consistent with the proper "functional approach" to the determination of obviousness as laid down in *Graham*. The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR* noted that the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit.

One of these exemplary rationales that may support a conclusion of obviousness set forth in subparagraph "C" relates to use of known technique to improve similar devices (methods, or products) in the same way.

> To reject a claim based on this rationale, Office personnel must resolve the *Graham* factual inquiries. Then, Office personnel must articulate the following:
>
> (1) a finding that the prior art contained a "base" device (method, or product) upon which the claimed invention can be seen as an "improvement;"

(2) a finding that the prior art contained a "comparable" device (method, or product that is not the same as the base device) that has been improved in the same way as the claimed invention;

(3) a finding that one of ordinary skill in the art could have applied the known "improvement" technique in the same way to the "base" device (method, or product) and the results would have been predictable to one of ordinary skill in the art; and

(4) whatever additional findings based on the *Graham* factual inquiries may be necessary, in view of the facts of the case under consideration, to explain a conclusion of obviousness.

The rationale to support a conclusion that the claim would have been obvious is that a method of enhancing a particular class of devices (methods, or products) has been made part of the ordinary capabilities of one skilled in the art based upon the teaching of such improvement in other situations. One of ordinary skill in the art would have been capable of applying this known method of enhancement to a "base" device (method, or product) in the prior art and the results would have been predictable to one of ordinary skill in the art. The Supreme Court in *KSR* noted that if the actual application of the technique would have been beyond the skill of one of ordinary skill in the art, then using the technique would not have been obvious. *KSR*, 550 U.S. at ___, 82 USPQ2d at 1396. If any of these findings cannot be made, then this rationale cannot be used to support a conclusion that the claim would have been obvious to one of ordinary skill in the art. *(emphasis added)*

The Applicants respectfully submit that the Examiner has failed to articulate each and every one of items (1) to (4) above as is required.

For example,

Regarding item (1) above, the Examiner appears to consider that GB 2161647 disclose a "base" method upon which the claimed invention can be seen as an "improvement;"

Regarding item (2) above, the Examiner appears to consider that Buchanan et al. disclose a "comparable" method (that is not the same as the base method) that has been improved in the same way as the claimed invention.

However, as pointed out above, in the Buchanan et al. method, when V2O5 is used as a sintering aid for the PZT powder, the PZT "was milled and blended with" V2O5 as dispersed in isopropyl alcohol (note V2O5 is dispersed, but not dissolved as in a real liquid phase). (Column 3, Lines 25-30.) This is merely dispersed solid particles, which is different from the real liquid phase precursor as set forth in independent claim 1 (Li-Bi solution). In other words, the Buchanan et al. document teaches away from the present invention. Although Buchanan et al. (U.S. 4,283,228) mentions ammonium vanadate, vanadyl salts, or V2O5-affording promoter generally (Lines 5-15 in Column 2, Line 25-35 in Column 4), these chemicals are simply intended to use as a source of V2O5 to react with PZT.

Thus, the Applicants respectfully submit that the Buchanan et al. method is not comparable to that of GB 2161647 nor does it improve the GB 2161647 method to arrive at the claimed invention.

In view of the above, the Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness.

At least for the reasons explained above, the Applicants respectfully submit that the combination of method steps as set forth in independent claim 1 is not disclosed or made

obvious by the combination of the prior art of record, including GB 2161647, Buchanan et al., Fernandez et al., and Srivastava et al.

Therefore, independent claim 1 is in condition for allowance.

Dependent Claims

The examiner will note that dependent claim 39 has been added to combine the subject matter of dependent claims 19, 29, 30, and 33 thereby raising new issues.

All dependent claims are in condition for allowance due to their dependency from allowable independent claims, or due to the additional novel features set forth therein.

Accordingly, reconsideration and withdrawal of the rejections under 35 U.S.C. §103(a) are respectfully requested.

JMS/CTT/ktp

CONCLUSION

All of the stated grounds of rejection have been properly traversed, accommodated, or rendered moot. It is believed that a full and complete response has been made to the outstanding Office Action, and that the present application is in condition for allowance.

If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, he is invited to telephone Carl T. Thomsen (Reg. No. 50,786) at (703) 208-4030(direct line).

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§1.16 or 1.17, particularly extension of time fees.

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Respectfully submitted,

By 

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